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Abstract

INTERACTION OF URANIUM WITH ALKALINE METAL FLUORIDES AND RECOVERY OF PLUTONIUM AND SOME FISSION ELEMENTS BY THEM

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Recently extensive studies have been made to determine the applicability of pyrochemical methods to processing irradiated uranium, the method of processing by molten salts draws investigators' attention. Most investigators use non-volatile uranium fluorides (UF_3, UF_4) as a rule, these fluorides are used in the mixture with alkaline earth and alkaline fluorides. On the basis of the thermodyanimic data the latter are usually considered inert diluents of a salt phase. In fact, however, the process is more complicated as it is necessary to take into account the volatility of an alkaline metal which is formed according to the following reaction:

$$M + nRF \rightleftarrows MF_n + nR,$$

where M is uranium, plutonium, etc., R is an alkaline metal.

As the volatility of an alkaline metal is quite appreciable, one can suggest the above reaction to be shifted to the right. Hence, alkaline metal fluorides can interact with U,Pu and most of fission elements. This problem has not yet been discussed from this point of view.

The present paper reports the results of the investigation of the interaction between alkaline metal fluorides and uranium (irradiated and unirradiated) and uranium-plutonium alloys in the wide temperature range (700° - 1300°C). The experiments have been made using resistance and induction furnaces and the inert gas atmosphere. Graphite, Zr carbide, nickel and tantalum crucibles have been employed for melting. The rate of uranium transition into salt has been studied as a function of salt phase composition, time, temperature and intensity of mixing, etc.

It is established that uranium interacts with alkaline metal fluorides

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to form trifluoride at 1250°C or tetrafluoride at 900°C and an alkaline metal.

According to the intensity of interaction, alkaline metal fluorides fall on the line on which the corresponding metals fall according to their volatility.

The study shows that all uranium can be transferred into potassium fluoride melt at 800-1000°C while it is transferred in tiny amounts into a salt mixture $LiF-CaF_2$, when the weight ratio is 1:10 and the temperature is 1250°C. Hence, by changing the salt composition it is possible to conduct the process up to the required limit either by transferring all uranium into salt, or transferring only Pu, some fission elements and partially uranium.

The experiments on the recovery of plutonium from Pu-U alloys into $LiF-CaF_2$ have been made both under static conditions and while mixing. The effect of changing the initial Pu concentration in uranium upon the rate of Pu recovery has been investigated.

It is established that practically all Pu (its residual content in uranium being less than 0.01 mg/g) can be recovered from uranium alloys by molten fluorides. The processing of irradiated U by the mentioned above salts shows that fission elements are recovered by 50-60% and the rare earths are recovered almost completely.

The possibility is examined of the recovery of uranium and other metals from salt concentrates by metal reduction.